NEDO Biomass Projects

12 March 2019

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Positioning of Biomass Energy and fuels

Bio-based Carbon Economy (Biotechnology-based Economy)

Biomass Energy

Power Generation/Heat

Food/Feed

Biofuels

Bioplastics

Biochemicals

Biorefinery

Biomedical

Source: NEDO TSC
Keeping in mind that Safety always comes first, in order to simultaneously achieve improvement of Energy Security, Economic Efficiency, and Environment Suitability (3E+S), continuous efforts are being implemented. It is indispensable to implement the multi-layered energy supply structure where each power source exhibits maximum performance and offsets weakness.

<table>
<thead>
<tr>
<th>3E+S</th>
<th>Energy Security</th>
<th>Economic Efficiency</th>
<th>Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety always comes first</td>
<td>Further exceeds before the earthquake (about 20%)</td>
<td>Reducing more than present costs (FY 2013 9.7 trillion yen ⇒ FY 2030 9.5 trillion yen)</td>
<td>Achieving reduction targets of greenhouse gas that are comparable to Western countries (In fiscal 2030, achieving -26% compared to fiscal 2013)</td>
</tr>
</tbody>
</table>

Source: Agency for Natural Resources and Energy, METI
Comparison of primary energy self-sufficiency of major countries

The energy self-sufficiency ratio of Japan in 2015 was 7.4% which was a low level even compared to other OECD countries.

Source: Agency for Natural Resources and Energy, METI
Comparison of renewable energy ratio to power output

As of 2016, the renewable energy ratio in the generated electric power amount of Japan is 14.5% (6.9% if hydroelectric power is excluded). It seems low compared to major countries, so expanding further is required.

Source: Agency for Natural Resources and Energy, METI
### Paris Agreement

<table>
<thead>
<tr>
<th>Country</th>
<th>compared to 1990</th>
<th>compared to 2005</th>
<th>compared to 2013</th>
</tr>
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<tbody>
<tr>
<td>Japan</td>
<td>▲18.0%</td>
<td>▲25.4%</td>
<td>▲26.0%</td>
</tr>
<tr>
<td>USA</td>
<td>▲14~16%</td>
<td>▲26~28% (until2025)</td>
<td>▲18~21%</td>
</tr>
<tr>
<td>EU</td>
<td>▲40% (until2030)</td>
<td>▲35%</td>
<td>▲24%</td>
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</table>
| China   | • Reduce carbon dioxide emissions per GDP by 60 to 65% compared to 2005 by 2030  
          | • Achieve the peak of carbon dioxide emissions by around 2030 |

Source: METI
New Political Target on Renewable Energy in Japan

• The target of 2030 energy mix is 22-24% of renewables in which 8.8-9.2% of hydro power, 7.0% of PV, **3.7-4.6% of biomass**, 1.7% of Wind, 1.0% of Geothermal.

Source: Ministry of Economy, Trade and Industry (METI)
Environmental measures
- Greenhouse gases (GHG) reduction
- Verification of greenhouse gas reduction

Energy security
- Japan's energy self-sufficiency is only 6%
- Fossil fuel is a finite resource

New Energy Law
(Act on Special Measures for the Promotion of New Energy Usage, etc., Apr 1997)
Biomass is a renewable, organic resource based on living organisms, excluding fossil resources. It consists of biomass resources used as raw material, types of energy use (electricity, heat, transport fuel, etc.) and energy conversion technology that connects them together. Also, biomass may be used for generating power and for heat without conversion but through direct incineration.

Biomass use is largely divided into material use as construction material, etc., and energy use. Effective utilization is possible by cascading, beginning with use as material and finally using as energy source. It can also be used to convert to liquid fuel for transport, etc., depending on the application.

Although biomass generates CO2 when incinerated for its energy, various CO2 that it had absorbed from air in its growth process (carbon neutral) and is therefore classified as renewable energy.
NEDO’s Biomass Energy & fuels Project

- **Base technology development for non-edible plant-derived bioethanol** (FY2007-FY2012)
- **Development of efficient elemental technologies for biofuel production** (FY2013-FY2016)
- **Project to develop integrated production system for ethanol from non-edible plant** (FY2009-FY2013)
- **Demonstration for integrated production system from cellulosic biomass** (FY2014-FY2019)
- **Development of production technologies for biojetfuels** (FY2017-FY2020)
- **Demonstration Program for Locally Sustainable Bioenergy System** (FY2014-FY2020)

**R&D projects about Algal Biofuels**

- **Next-generation biofuels development other than ethanol** (FY2010-FY2016)
Fuel Ethanol from Cellulosic biomass
Nearly all of the fuel consumed by the transport section, which accounts for approximately 23% of primary energy use in Japan, is liquid fuel. Despite the shift to EVs and FCVs, the existing internal combustion mechanism (in developing countries and used car market) and transport functions that require high-energy density that cannot be replaced with storage battery (large vehicles, maritime vessels, aircraft, etc.) continues to require liquid fuel.

With the development and production of biomass-derived alternative fuel that does not compete with food production (cellulose-based biomass), GHG output by the transport sector must be reduced.
Installing bioethanol in automobile is a promising solution to reduce CO2 emissions of transportation sector which accounts for about one-fourth of energy consumption.

NEDO is developing technology to produce second-generation bioethanol in an economical manner. Pulp waste, coffee waste, and depleted mushroom substrates are collected and the fiber structures of such materials are ruptured using an explosion process and then are saccharified and fermented to produce bioethanol.

Its target is reducing 50% of GHG compared with gasoline, more than two times of energy are generated from input and cost competitive with ethanol produced overseas.

1. Determining best combinations of elemental process technologies, and feasibility study
2. Development of high efficiency production technology
Bio Jet Fuel
In order to curb CO2 emission in the air transport sector, ICAO (UN organization for the sector) announced the target of **not increasing CO2 emission in 2020 and later.**

Use of bio jet fuel is anticipated as a means to reduce CO2 emission.
The world's first bio jet fuel supply, employing shared fuel storage facility, has started at Norway's Oslo Airport in January 2016. In March 2016, bio jet fuel supplies started at Los Angeles Airport in the US.
Development of Production Technologies for Bio Jet Fuels

- Algae
- Cellulosic Biomass
- Large Scale Cultivation
- Gasification Purification
- Syngas
- Extraction Purification Reforming
- Liquefaction Reforming
- Alternative Aviation Fuels with Bio Jet Fuels
Development of an Integrated Pure Bio Jet Fuel Production
Employing Fast-Breeding Botryococcus Braunii

Technology development is conducted on an integrated manufacturing process for bio jet fuel derived from microalgae.
Plant containing a cultivation pond in the scale of 10,000 m² is built in Thailand, for pilot-scale test employing fast-breeding Botryococcus braunii.
Additionally, issues involved in industrialization with greater efficiency and their solutions are examined for verification into the feasibility of stable, long-term and continuous operation, reduction of production cost, etc.

Location: Saraburi Province, Thailand (on property owned by Siam Cement Group)
Demonstration period: FY2017-FY2020
Regional & Sustainable Biomass Energy System
Biomass energy is an energy source that stands out among renewable energy sources in providing stable electric power generation and that contributes to local community revitalization.

After the introduction of the feed-in tariff system in 2012, use based on the system expanded. On the other hand, the following issues make purchasing independent of the system difficult under current conditions.

In order to promote biomass energy use independent of the FIT system, these issues must be resolved.

1. **Economic viability cannot be secured without FIT (fuel cost accounts for 70% of cost for wood biomass power generation)**
   → Fuel cost reduction & diversification of income sources

2. **Securing stable raw material procurement**: Supply of unused materials and waste over a long-term period is difficult

### Energy input in facilities (already in operation)

<table>
<thead>
<tr>
<th>Biomass type and purchase price</th>
<th>Feed-in tariff purchase Prior to system start</th>
<th>Feed-in tariff system After system start</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unused materials</td>
<td>20,000 kW</td>
<td>400,000 kW</td>
<td>420,000 kW</td>
</tr>
<tr>
<td>Wood in general, etc.</td>
<td>160,000 kW</td>
<td>480,000 kW</td>
<td>640,000 kW</td>
</tr>
<tr>
<td>Recycled materials</td>
<td>440,000 kW</td>
<td>40,000 kW</td>
<td>480,000 kW</td>
</tr>
<tr>
<td>Wastes &amp; materials other than wood</td>
<td>1680,000 kW</td>
<td>210,000 kW</td>
<td>1890,000 kW</td>
</tr>
<tr>
<td>Methane gas</td>
<td>20,000 kW</td>
<td>30,000 kW</td>
<td>50,000 kW</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>Approx. 2300,000 kW</strong></td>
<td><strong>1160,000 kW</strong></td>
<td><strong>Approx. 3460,000 kW</strong></td>
</tr>
</tbody>
</table>

### The cost structure for wood biomass power generation

- Fuel cost: 68%
- Depreciation: 9%
- Labor cost: 11%
- Maintenance & inspection cost: 6%
- Ash processing cost: 6%

Fuel cost accounts for nearly 70% of cost

※Wood biomass power plant (5700 kW) current operating under FIT certification

• The nuclear power plant accident in 2011 became a turning point for the Japanese government to accelerate the growth of renewable energy
• Feed-in-tariff (FIT). Woody biomass has especially attracted attention for use.
FIT generation plans of biomass

- Domestic waste and Others: 1.24 Mln kW
- Construction waste: 0.96 Mln kW, 0.37 Mln kW, 0.42 Mln kW
- General woody waste (Import biomass): 2.74 Mln kW, 4 Mln kW
- Forest thinnings (Domestic biomass): 0.24 Mln kW, 0.51 Mln kW
- Methane fermentation: 0.16 Mln kW, 0.11 Mln kW

※March 2017

- Installed capacity (transition)
- Installed capacity (new)
- Certification capacity
- Forecast (government goal)
Biomass energy regional independent demonstration

- To save the transportation cost of raw materials, biomass power plant and heat utilization are suitable for deploying at local levels together with cooperation of local authority.
- NEDO is supporting F/S and demonstration project of collecting biomass, transforming to electricity and heat, and supplying neighborhood. NEDO is supporting models without relying on FIT.
- Biomass power plant is expected to be carbon-free adjustable resources for balancing demand and supply of electricity.

(1) Technical guidance & introduction requirement
- Study of past demonstration projects
- Overseas trend survey
- Hearing survey, etc. (researched 139 places and more)

(2) Demonstration project regional sustainable system
- Feasibility study (FS) for regional demonstration
- Reflection the results of FS
- Selection by result of feasibility study (FS)
- Demonstration regional sustainable system
- Inspection of regional sustainable system for biomass energy
- Reflection of the results of demonstration projects

(3) Development of technology for regional sustainable system
- Implement development of elemental technology

Technical problems extracted by demonstration project

We conducted a hearing survey with the aim of finding out the overall picture of the regional system with business potential and the point of "what kind of point should be devised as a project" (139 places in total)

As of Mar. 7, 2018
Key points in the regional autonomous system

Nationwide interview survey

Total image of an economically feasible regional system and what to do to make it viable as a business operation? Interview survey was conducted with focus on these points (Total of 139 locations)

As of March 7, 2018

What are the "strengths" of businesses and communities?

4 ideas

1. Raw material procurement
2. Energy use
3. Energy conversion
4. Total system (Coordination with the community)

Balance between raw materials and energy demand

Agreement with local communities (Win-Win Relationship)

Establishment of technical indicators & implementation criteria for businesses

Wood material businesses 35 locations
Methane fermentation businesses 17 locations
Manufacturers 20 locations
Prefectural governments 13 locations
Municipal governments 12 locations
Universities & research institutes 7 locations
Users 6 locations
Forestry cooperatives 6 locations
Municipal cooperatives 1 location
Fuel production businesses 17 locations
## Demonstration project

<table>
<thead>
<tr>
<th>Operation type</th>
<th>Description of operation</th>
<th>Subsidy recipient</th>
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</thead>
<tbody>
<tr>
<td>1 Methane Fermentation type</td>
<td>The project aims at the use of various types of mixed biomass that is generated in the region for production of biomass energy with dry methane fermentation technology. For this purpose, system is developed to promote wider utilization through coordination with neighboring regions.</td>
<td>Fuji Clean Co., Ltd.</td>
</tr>
<tr>
<td>2 Methane Fermentation type</td>
<td>The project aims at energy conservation for dairy farms and the community with production of quality compost and liquid fertilizer, quality livestock feed and milk production. It also aims at reduction of foul odor, groundwater contamination and financial burden on cooperative members with a reduction in animal waste treatment fees.</td>
<td>Japan Agricultural Cooperatives Akan</td>
</tr>
<tr>
<td>3 Wood</td>
<td>The project aims at collection of usable biomass resources in the region for use as energy for diatomaceous earth drying at existing factories, as well as use of surplus heat.</td>
<td>Showa Chemical Industry Co., Ltd.</td>
</tr>
<tr>
<td>4 Wood</td>
<td>The project aims at use of construction wastes and low-grade wood biomass containing foreign matter, that does not compete against wood biomass produced in a wide range of area centering on Kurashiki City, Okayama Prefecture, for fueling boilers and supplying steam to industrial complexes.</td>
<td>JFE Environmental Services Corporation</td>
</tr>
<tr>
<td>5 Wood</td>
<td>Bamboo, material that has become an issue in the region, is utilized effectively for high-efficiency supply of both power and heat via ORC unit to bamboo processing plant and primary material processing plant.</td>
<td>Bamboo Energy Co.</td>
</tr>
<tr>
<td>6 Wood</td>
<td>Chipping rotary is utilized for production of wood chips from timber residue materials and transport of the chips for efficient wood biomass fuel production. Forest residue material collection system is developed, and stable supply of wood chips is promoted.</td>
<td>Tajima Forest K.K.</td>
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</table>
Thank you very much for your kind attention